

**XXVI. Sequel to the Thoughts on the constituent Parts of Water  
and Dephlogisticated Air. In a Subsequent Letter from Mr.  
James Watt, Engineer, to Mr. De Luc, F. R. S.**

Read May 6, 1784.

DEAR SIR,

Birmingham,  
April 30, 1784.

**O**N re-considering the subject of my letter to you of the 26th of November last, I think it necessary to resume the subject, in order to mention some necessary cautions to those who may chuse to repeat the experiments mentioned there, and to point out some circumstances that may cause variations in the results.

In experiments where the dephlogisticated air is to be distilled from common or cubic nitre, these salts should be purified as perfectly as possible, both from other salts and from phlogistic matter of any kind; otherwise they will produce some nitrous air, or yellow fumes, which will lessen the quantity, and, perhaps, debase the quality of the dephlogisticated air. If the nitre is perfectly pure, no yellow fumes are perceptible, until the alkaline part begins to act upon the glass of the retort, and even then they are very slightly yellow.

When earthen retorts are used, and a large quantity of air is drawn from the nitre, it acts very much upon the retort, dissolves a great part of it, and becomes very alkaline, retaining only a small part of its acid, at least only a small part which



can be made appear in any of the known forms of that acid; and unless retorts can be obtained of a true apyrous and compact porcelain, I should prefer glass retorts, properly coated, for making experiments for the present purpose.

In some of my experiments the nitre was left in the retort placed in a furnace, so that it took an hour or more to cool. In these cases there was always a deficiency of the acid part, which seemed, from some appearances on the coating, either to have penetrated the hot and soft glass, by passing from particle to particle, or to have escaped by small cracks which happened in the retort during the cooling. There was the least deficiency of the acid when the distillation was performed as quickly as was practicable, and the retort was removed from the fire immediately after the operation was finished. In order to shorten the duration of the experiment, and consequently to lessen the action of the nitre on the retort, it is advisable not to distil above 50 ounce measures of dephlogisticated air from an ounce of nitre. The experiment has succeeded best when the retort was placed in a charcoal fire in a chafing-dish or open furnace; because it is easy in that case to stop the operation, and to withdraw the retort at the proper period.

When the dephlogisticated air is distilled from the nitre of mercury, the solution should be performed in the retort itself, and the nitrous air produced by the solution should be caught in a proper receiver, and decomposed by the gradual admission of common air through water; and the water, which thus becomes impregnated with the acid of the nitrous air, should be added after the process to the water through which the dephlogisticated air has passed. When the solution ceases to give any more nitrous air, the point of the tube of the retort should be raised out of the water; otherwise, by the condensation of the

watery and acid vapours which follow, a partial exhaustion will take place, and the receiving water will rise up into the retort and break it, or at least spoil the experiment. A common receiver, such as is used in distilling spirit of nitre, should be applied, with a little water in it, to receive the acid steam; and it should be kept as cool as can conveniently be done, as these fumes are very volatile. This receiver should remain as long as the fumes are colourless; but when they appear, in the neck of the retort, of a yellow colour, it is a mark that the mercurial nitre will immediately produce dephlogisticated air; the receiver should then be withdrawn, and an apparatus placed to receive the air. The rest of the process has been sufficiently explained in my former letter.

The phlogisticated nitrous acid, saturated by an alkali, will not crystallize; and, if exposed to evaporation, even in the heat of the air, will become alkaline again, which shews the weakness of its affinity with alkalies when dissolved in water\*; a farther proof of which is, that it is expelled from them by all the acids, even by vinegar (which fact has been observed by Mr. SCHEELE). I have observed, that litmus is no test of the saturation of this acid by alkalies; for the infusion of litmus added to such a mixture will turn red, when the liquor appears to be highly alkaline, by its turning the infusions of violets, rose leaves, and most other red juices, green. This does not proceed from the infusion of litmus being more sensible to the presence of acids than other tests; for I have lately discovered a test liquor (the preparation of which I mean to publish soon) which is more sensible to the presence of acids

\* You have informed me, that Mr. CAVENDISH has also observed this fact; and that he has mentioned it in a paper lately read before the Royal Society; but I had observed the fact previous to my knowledge of his paper.

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than litmus is; but which turns green in the same solution of phlogisticated nitre that turns litmus red.

The unavoidable little accidents which have attended these experiments, and which tend to render their results dubious, have prevented me from relying on them as *full* proofs of the position that no acid enters into the composition of dephlogisticated air; though they give great probability to the supposition. I have, therefore, explained the whole of the hypothesis and experiments with the diffidence which ought to accompany every attempt to account for the phænomena of nature on other principles than those which are commonly received by philosophers in general. And in pursuance of the same motives it is proper to mention, that the alkali employed to saturate the phlogisticated nitrous acid, was always that of tartar which is partly mild; and I have not examined whether highly phlogisticated nitrous acid can perfectly expel fixed air from an alkali, though I know no fact which proves the contrary. It should also be examined, whether the same quantity of real nitrous acid is requisite to saturate a given quantity of alkali, when the acid is phlogisticated, as is necessary when it is dephlogisticated.

As I am informed that you have done me the honour to communicate my former letter on this subject to the Royal Society, I shall be obliged to you to do me the same favour in respect to the present letter, if you judge that it merits it.

I remain, &c.

JAMES WATT.

